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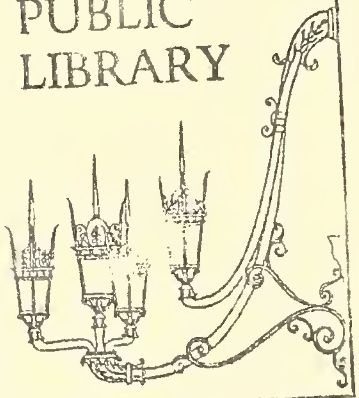

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BOSTON REGIONAL SURVEY

RESEARCH MEMORANDUM

SUBDIVISIONS OF THE BOSTON METROPOLITAN REGION FOR ANALYTIC PURPOSES

Prepared for the

MASS TRANSPORTATION COMMISSION
COMMONWEALTH OF MASSACHUSETTS
120 Tremont Street, Boston, Massachusetts

MARCH, 1962

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I. PURPOSE OF THE MEMORANDUM

It is important in a study such as the Boston Regional Survey, dealing with a series of transportation studies in a relatively large metropolitan region, to make some geographical sub-division of the area in question. The assumption underlying such a geographical subdivision is that for every transportation decision or recommendation there is a related geographic diffusion of benefit or cost in terms of service, as well as social and economic effects.

A geographical subdivision of the metropolitan area can serve several purposes:

1. It can help to define common area units as a basis for analyzing and interpreting the variety of data available from previous studies. In this respect it should help to unify the varying geographical concepts of coverage used by the different studies.
2. In the process of developing such a geographic subdivision some preliminary conclusions can be derived regarding the location and coverage of the various transportation networks.
3. By delineating areas with a high degree of relationship or comparability, the division can be of use in future planning for regional action.

Geographical classification of the area should relate directly to transportation variables. This implies that the geographical pattern of movement of goods and persons within the metropolitan area should serve as the main basis of classification. The geographical subdivision should also have some theoretical justification. Here the major assumption is that activities and people in a metropolitan area are not only distributed in space in an orderly manner but that this systematic distribution can be logically related to the elements of the transportation network.

II. CLASSIFICATION PROCEDURE

It is proposed that a sector and zone division be used as a geographic framework for analysis in evaluating transportation, economic and related studies that have been conducted in the Boston Metropolitan Region. It is believed that the sector and zone method of delineation best describes the pattern of intra-metropolitan migration and distribution of activity within the region. and at the same time can be adapted to meet the requirements outlined earlier in this memorandum. The procedure used in delineating the sectors and zones of the metropolitan region was as follows:

1. Sector Division.

The area-unit of analysis was taken as the city or town. A transparent template was constructed consisting of a circle with nine 40 degree wedges. This template was superimposed over a map of existing and proposed highway facilities in the Boston region. The template was then rotated so that at least one major radial highway was centered in the middle of each 40 degree sector. Whenever more than half of a city or town was included in a sector, the whole municipality was delineated as belonging to that sector. Topography, namely Boston Harbor to the east, was responsible for eliminating two of the nine sectors. Also because of topography (and perhaps for some other reasons not known at present) not all the radials were in the middle of their respective sectors of influence for their entire length. In one particular direction from Boston two radials run rather close together (Routes 3 and 93). As a result, after several attempts at rotation it became apparent that at least one sector would be traversed by two major radials and that with only a slight change in the degree of rotation several municipalities lying along the edge of various sectors could be included in one or another sector. Priority was given to completed or existing highways when centering them in sectors. Wherever there was doubt regarding borderline towns, the sector system proposed was based on comparability with the few previous studies which used a sector division.

2. Zone Division.

The zonal division was accomplished using the same point as the fixed center. Seven mile intervals from the center were adopted since any smaller division was found to result in too many zones for convenient use in analysis. The seven mile interval also most conveniently overlaid existing and proposed circumferentials in such a way that they were in most cases centered within a zone of two tiers of communities, one on each side of the highway. In the case of the densely populated first interval a subdivision was considered to create two smaller zones: one which included the most central cities and towns and corresponded to the Inner Belt circumferential (Route 695) and the other which included the inner suburbs and corresponded to the proposed "intermediate belt." However, because of the varying shapes and sizes of municipalities in and near central Boston it was possible only to delineate a northern tier or inner suburbs and therefore no attempt was made to delineate separate inner zones. Further division of some of the central cities and surrounding towns might be desirable on the basis of smaller traffic zones or census tracts.

3. Sector-Zone Summary.

The proposed sector and zonal divisions have been combined on one map (see Figure 1). Altogether, there are seven sectors, each labeled according to the general direction from the central city. There are a total of four zones, the first of which includes all central cities and close-in suburbs. The second zone may be designated as "intermediate suburbs" and corresponds to the area of influence of Route 128. The third zone can be called "outer suburbs" and has no corresponding highway, while the fourth ring corresponds to the outer circumferential (Route 495).

According to the Route 128 study*, after Route 128 traverses Danvers

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* See Appendix I for full titles of major studies cited in this memorandum.

it is no longer functioning as a circumferential but has more the nature of a radial. Zonal adjustments were therefore made in the northeast sector to account for this change in function and direction (i. e., Route 128 was considered as a radial instead of as a circumferential).

III. USES OF THE CLASSIFICATION

The remainder of this memorandum is devoted to an analysis of how the proposed division of the Boston region into sector and zones can meet the requirements enumerated in the first section.

1. Comparability of Studies.

Several of the major transportation studies of the Boston region have used the zone-sector division as a means of geographical classification. Although the use of the method by these studies establishes some comparable basis for evaluation, the method has been applied differently in each study.

a. The GBESC study divided the Greater Boston Area into three zones and eight sectors for the purposes of population and economic projection (see Figure 2). There is one more sector and one less zone in the GBESC study compared to the division proposed for this study. The principal difference in regard to sectors is that the GBESC study has four southern sectors as compared to the three proposed in this memo. As a result, the GBESC Southwest sector lacks a major radial highway. Since the focus of the Boston Regional Survey is primarily oriented to transportation it would be difficult to use the GBESC division because in the absence of a planned or proposed highway in the Southwest sector, it would be difficult to relate economic and social changes in the sector to a transportation variable (in this case a major radial highway). In most other major respects the GBESC sector division conforms to the one proposed in this memo. Variations are found chiefly in "border" towns such as Ashland, Hopkinton, Upton, Bedford, Belmont, Carlisle, Canton, Sharon, Foxborough and Westford.

The variation of the zonal division in the GBESC study is more markec from the one proposed in this study. The GBESC inner zone is

roughly comparable to the inner zone proposed in this study except for its omission of Lynn, Saugus, Nahant, Quincy and Milton. The GBESC second zone is comprised of communities in the vicinity of Route 128 and, although slightly larger, generally corresponds to the second zone proposed for this study. Communities such as Concord, Bedford, Dover, Sharon, Stoughton, Avon and Holbrook are included in the GBESC second zone but are excluded from the comparable zone in this study. The GBESC's third zone includes the whole area between the outer Route 128 communities and the communities on the farthest side of Route 495 (or the limits of the GBESC study area.) This area is divided into two zones in the proposed subdivision, a procedure which leaves one zone without an existing or planned circumferential.

b. The Inner Belt study has made the most comprehensive use of the zone-sector division (see Figure 3) of the Boston region. It has one more zone and the same number of sectors as proposed in this study, but differs markedly in its internal division. Except for the exclusion of Lynnfield, the Inner Belt study's Northeast sector is essentially the same as proposed in this study. In the division of the northern group sectors, however, the Inner Belt study delineates a narrower "North" sector including only those communities traversed by Route 93 from Boston to Lawrence. The Northwest sector, on the other hand is delineated as being influenced by two radials (Route 2 and 3) and is much wider than the Northwest sector as proposed by this study. As a result, the Inner Belt study's West sector is shifted slightly to the south: for example, the communities of Stow and Maynard are included in the Northwest sector and excluded from the West sector; the communities of Sherborn and Holliston are included in the West sector and excluded from the Southwest sector. In contrast to the proposed division in this study, the two southern sectors

are drawn with Stoughton and Easton included in the Southwest sector and excluded from the South sector. In general, the Inner Belt division results in sectors which are less equal in size than those delineated for this study. This is primarily due to the relatively narrow size of the Inner Belt study's North and South sectors.

The Inner Belt study's first zonal division is considerably smaller than the comparable zone in this study. In fact, all of the towns and municipalities in the first two zones of the Inner Belt study except Waltham, Newton, Winchester and Stoneham are included in the first zone of this study. The latter towns, together with the third zone as defined by the Inner Belt study, are equivalent to the Route 128 (or second) zone in this study except for the inclusion of Dover and Bedford. The Inner Belt fourth zone is in many respects narrower than the third zone as proposed by this study, but is similar in the respect that it lacks an existing or proposed circumferential. The fifth Inner Belt zone, because of the smaller scope of the study area, only includes the communities on the inner rim of Route 495.

c. The Boston College Seminar study uses a sector division only, although more detailed analysis is provided for downtown Boston (see Figure 4). Six sectors are used instead of the seven proposed by this study. In the Boston College study, the South and Southeast sectors proposed in this study are consolitated into a single very large South sector while the West sector is slightly larger and the Southwest sector slightly smaller than the corresponding sectors proposed in this study. The three northern sectors are essentially the same as those in this study, but differences in the delineation of so-called "border" towns between the North and Northwest sectors result in a situation where Route 3 doesn't lie wholly in either sector of the Boston College study. The same is true of the Southwest Expressway

(Route 95) relative to the South and Southwest sectors. Great variation in size of sectors and the difficulty of assigning highways to single sectors appear to create some difficulties in this scheme.

d. The Route 128 study utilized two kinds of division of the Boston region. For its study of broader social and economic trends it subdivided the Boston region into five sub-areas, but not according to any sector-zone scheme. For its study of traffic characteristics, it subdivided the Boston region into three zones(see figure 5). The first zone is just slightly smaller than the first zone delineated in this study. The second zone corresponds closely to the second proposed in this study and the third includes all towns outside the second zone of the Route 128 study.

2. Area of Coverage.

The total area of coverage (see figure 6) of the various major studies being analyzed as a part of the Boston Regional Survey varies from the 149 cities and towns of the GBESC area to the 24 cities and towns covered in the 1948 Master Highway Plan and Coverdale and Colpitts Report. The Inner Belt study area covers 121 cities and towns. The Route 128 study uses the 1950 Standard Metropolitan Area as a basis for coverage.

More crucial for purposes of analysis is the smallest unit of area used in the various studies (see Table 1). Since most economic and social data is only available on the basis of cities and towns as the smallest reporting unit, this study has chosen the town as the principal unit for statistical analysis. This procedure is likewise followed in the Whitten and GBESC reports and to some extent in the Boston College, Route 128, and Inner Belt studies. The principle variation in units for area analysis arises in regard to studying traffic. The less dense development characteristic of suburban towns requires, in some cases, consolidation of several towns into one traffic zone in order to have a meaningful unit for traffic analysis. Conversely, the more intensively developed cities

TABLE I

AREA OF COVERAGE AND UNIT OF STUDY FOR MAJOR STUDIES OF THE BOSTON METROPOLITAN REGION

		Total Coverage	Smallest Area Unit	
Study*	Date	(cities & towns)	City of Boston	Other
WHITTEN	1930	39	12 sub-districts	38 towns
MAGUIRE	1948	24	17 zones 177 sectors	121 zones 471 sectors
COVERDALE & COLPITTS	1957	24		
ROUTE 128	1958	65 (soc. & econ.)	---	65 towns
		48 (traffic)	---	3 bands (larger than towns)
INNER BELT	1959	121 (zone-sector)	----	263 traffic generating nodes
B.C. SEMINAR	1960	100	15 sub-districts	64 zones: 5 sub-district 35 towns 24 groups of towns
GBESC	1959	149	---	149 cities & towns
BOSTON REGIONAL SURVEY (MTC)	1961	14~~3~~4	---	14~~3~~4 cities & towns

* See Appendix I for full titles of cited reports.

and towns of the region require subdivision into smaller traffic zones for analysis of traffic generation characteristics. In either case the traffic zones thus delineated do not coincide with town boundaries. This difficulty can, in part, be overcome by consolidating suburban town social and economic data to coincide with traffic data. In the case of central cities, census tract data and specialized detailed studies can be used to correspond to data from traffic zones that are smaller than the city or town. Several difficulties remain, however. First, the delineation of the Boston region into zones and sectors presented in this memorandum was accomplished by assigning whole towns to one sector or zone. This demarcation may result in a splitting up of consolidated suburban traffic zones or the inclusion of several traffic zones that are smaller than one town. As a result, there may be trouble in establishing comparability between zone and sector traffic data and social and economic data. Second, the varying size of central city and suburban traffic zones results in difficulty in making meaningful comparisons of social and economic variables in these zones because the size of the basic area unit may seriously effect the measurement of some variables (e.g., density). Third, the varying size of zone, particularly suburban zones, introduces a bias when traffic is assigned to an existing or proposed transportation system on the basis of alternative and terminal travel times The large, low density, congestion-free suburban traffic zones are sure to have significantly different terminal travel distances as compared to the quite small, congested, intown traffic zones.

The Inner Belt study uses 263 single points or traffic generating nodes or centroids to represent traffic zones. Under this procedure it is necessary for the traffic zones to be quite small in order for the single point to be representative of an entire zone. For each node there also must be social and economic data for the gravity model. However, the Inner Belt study had to use approximate methods of proportionality to allocate social and economic data to points representing such small zones.

As long as data in the various studies is collected in such a manner that large consolidated suburban traffic zones can be disaggreated into communities or as long as smaller-than-municipality inner traffic zones can be re-consolidated to represent individual communities, traffic data and socio-economic data can be obtained while using the town as the basic unit of area. Because of the varying shape and size of towns in regard to area, the bias inherent in comparing basic area units of different size will remain. This situation will also be true for the same reason when individual towns are consolidated into districts based on sector and zone.

3. Relation to Transportation Variables

If the zone-sector system of geographic classification of the Boston region is to be valid, the areas so subdivided must relate directly to transportation variables, such as the geographic pattern of traffic flow, the location of proposed and existing elements in the highway network and the location or coverage of other major transportation networks. In 1930, the Whitten O&D survey estimated the amount of traffic between pairs of traffic districts in the Boston region. By using the most direct route between towns and ignoring the location of existing highways, a schematic diagram was derived showing the direction of traffic flow within the area. The diagram showed a series of eight "idealized" radial routes and three even more idealized circumferential routes. The existing and proposed limited access highway plan as proposed and developed in the 1948 Master Highway Plan and subsequent reports conforms to this scheme. Thus, the radial and circumferential location pattern of existing and proposed highways appears to be based on the fact of existing radial and lateral traffic flows or desires. Both the radial and circumferential desires appear to occur at regular geographic intervals and as such conform to the proposed zone-sector division.

Each zone in the subdivision of the metropolitan region conforms to lateral traffic flows between towns and can be further related to existing and

proposed circumferentials designed accommodate these flows. It should be noted that three circumferential flows were identified in the Whitten report: the first and third correspond roughly to the Inner Belt and the Route 128 circumferential as proposed in the 1948 Master Highway Plan; the second corresponds to the intermediate belt as proposed in the Boston College Seminar report. No circumferential movement of metropolitan scope is shown in the Whitten or subsequent reports to justify the Outer Belt (Route 495) although such a justification does occur in limited scope for the communities of Lowell, Lawerence and Haverhill based on a highway study for the Merrimack region in 1954. One possible validation of such an extended route probably lies in the idea of a lateral connection of a series of hinterland cities at the same approximate distance from Boston as the Merrimack Valley cities, such as Hudson, Marlboro, Brockton, and Attleboro. These cities are located at a substantial distance from Boston, which may explain why there is a greater geographical gap between Route 128 and Route 495 than between other circumferential routes. Beyond Route 128, but closer to Boston than Route 495, there appears to be a zone that has no corresponding existing or proposed circumferential. This is because the proposed zone delineation assumes a relatively constant spacing of circumferential traffic desires. This zone might have been a logical choice for a new Outer Belt highway had not other considerations taken precedence.

APPENDIX I

TITLES OF CITED STUDIES

Name Used in Text	Complete Citation
BOSTON COLLEGE SEMINAR STUDY	Studies of Urban Transportation, Travel in the Boston Region 1959-1980, Seminar Research Bureau, Boston College, Boston. Volume I - January, 1960 Volume II - Trip Distribution Procedures, February, 1961 Volume III - An Evaluation of Transportation Needs, April, 1961
COVERDALE & COLPITTS	Report on Traffic Studies for the Boston Metropolitan Area, Massachusetts Department of Public Works, Coverdale and Colpitts, Consultants, New York, 1959.
GBESC STUDY	The Population of the Cities and Towns of Greater Boston Projected to 1970, Economic Base Report No. 4, Greater Boston Economic Study Committee, Associates for the Committee for Economic Development, Boston, 1959 (As Revised, February 21, 1961).
INNER BELT STUDY	Inner Belt and Expressway System, Boston Metropolitan Area, for Massachusetts Department of Public Works, Interim Report, Hayden, Harding & Buchanan, Inc. and Charles A. Maguire & Associates, Consultants, Boston, 1960.
MASTER HIGHWAY PLAN OR MAGUIRE REPORT	The Master Highway Plan for the Boston Metropolitan Area, Joint Board for the Metropolitan Master Highway Plan, Based Upon a Traffic Survey by the Department of Public Works, Public Roads Administration, Federal Works Agency, Charles A. Maguire Associates, Consultants, Boston, 1948.

APPENDIX I
(Continued)

Name Used in Text	Complete Citation
MERRIMACK VALLEY MASTER HIGHWAY PLAN	A Master Plan of Highways for the Lowell-Lawrence-Haverhill Metropolitan Areas, for Massachusetts Department of Public Works and Bureau of Public Roads, Edwards, Kelcey and Beck, Consultants, Boston, 1956.
ROUTE 128 STUDY	Economic Impact of Massachusetts Route 128, for Massachusetts Department of Public Works and U. S. Bureau of Public Roads, Transportation Engineering Division, Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, 1958.
WHITTEN REPORT	Report of an Thoroughfare Plan for Boston, Prepared by the City Planning Board, Robert Whitten, Consultant, Boston, 1930.

APPENDIX II

LIST OF CITIES AND TOWNS BY PROPOSED SECTORS AND ZONES

	ZONES			
SECTORS	A Central City & Suburbs (Inner and Intermediate Belts)	B Intermediate Suburbs (Route 128)	C Outer Suburbs (No highway)	D Fringe (Route 495)
1. (Northeast)	No sector subdivision Boston Cambridge Somerville Brookline Everett Revere Chelsea Winthrop Watertown Belmont Arlington Medford Malden Melrose Lynn Nahant Saugus Quincy Milton	1-B Lynnfield Peabody Danvers Salem Marblehead Swampscott	1-C-1 Middleton Topsfield Boxford Ipswich Rowley Georgetown Newbury 1-C-2 Hamilton Wenham Beverly Essex Manchester Cloucester Rockport	1-D Merrimac West Newbury Amesbury Newburyport Salisbury
2. (North)		2-B Winchester Stoneham Wakefield Woburn Reading Burlington	2-C North Reading Wilmington Billerica Boxford Carlisle	2-D-1 Lowell Dracut Tewksbury Dunstable Tyngsborough Westford Chelmsford

APPENDIX II
(Continued)

LIST OF CITIES AND TOWNS BY PROPOSED SECTORS AND ZONES

	ZONES			
SECTORS	A Central City & Suburbs (Inner & Intermediate Belts)	B Intermediate Suburbs (Route 128)	C Outer Surburbs (No highway)	D Fringe (Route 495)
2. (North) (Continued)				2-D-2 Lawrence Methuen Andover No. Andover
				2-D-3 Haverhill Groveland
3. (Northwest)		3-B Lexington Lincoln	3-C Concord Acton	3-D Littleton Boxborough Harvard Ayer Groton
4. (West)		4-B Waltham Newton Weston Wellesley Needham	4-C Wayland Natick Maynard Sudbury Framingham	4-D Stow Hudson Marlborough Southborough Ashland Bolton Berlin Northborough Westborough Hopkinton Upton

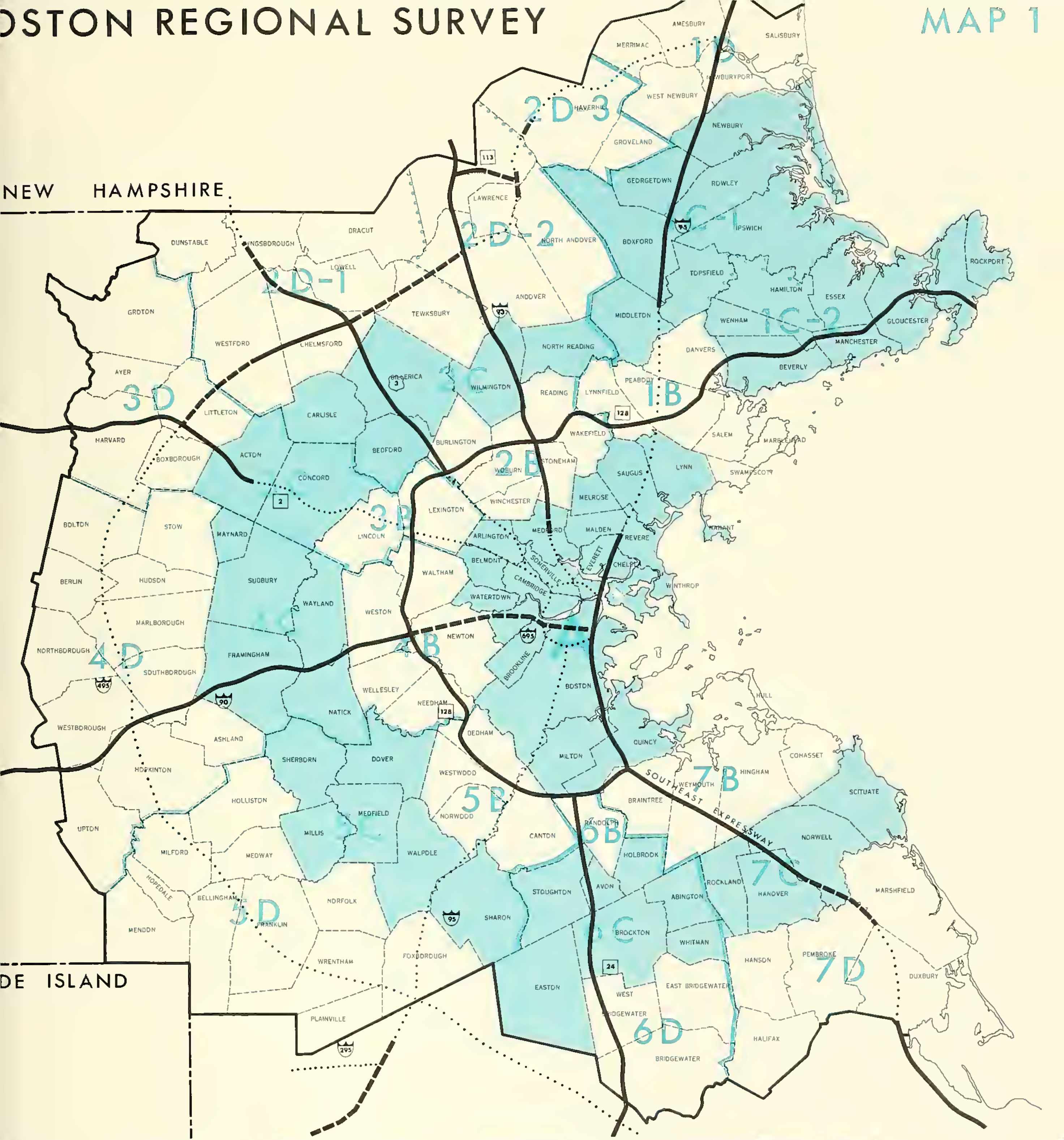
APPENDIX II
(Continued)

LIST OF CITIES AND TOWNS BY PROPOSED SECTORS AND ZONES

	ZONES			
SECTORS	A Central City & Suburbs (Inner & Intermediate Belts)	B Intermediate Suburbs (Route 128)	C Outer Suburbs (No highway)	D Fringe (Route 495)
5. (Southwest)		5-B Dedham Canton Westwood Norwood	5-C Dover Walpole Sharon Medfield Sherborn Millis	5-D Holliston Medway Norfolk Foxborough Milford Bellingham Franklin Wrentham Plainville Hopedale Mendon
6. (South)		6-B Randolph	6-C Holbrook Avon Stoughton Abington Whitman Brockton Easton	6-D East Bridgewater W. Bridgewater Bridgewater
7. (Southeast)		7-B Braintree Weymouth Hingham Cohasset Hull	7-C Rockland Hanover Norwell Scituate	7-D Hanson Pembroke Marshfield Duxbury Halifax

OSTON REGIONAL SURVEY

MAP 1



OPOSED SECTOR AND
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LETTERS INDICATE ZONE

NUMBERS INDICATE SECTOR

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GENERAL INFORMATION

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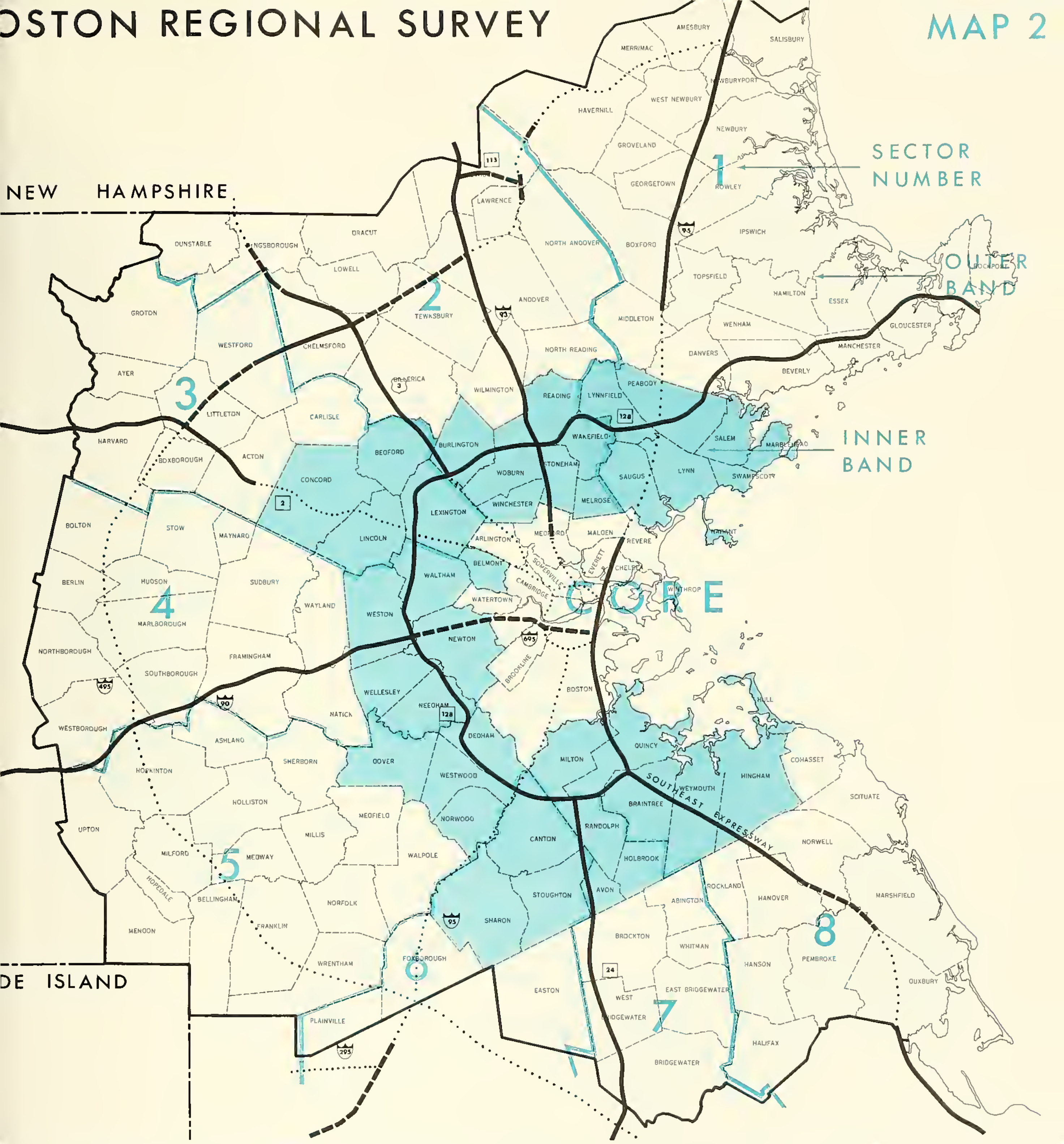
MAP 2



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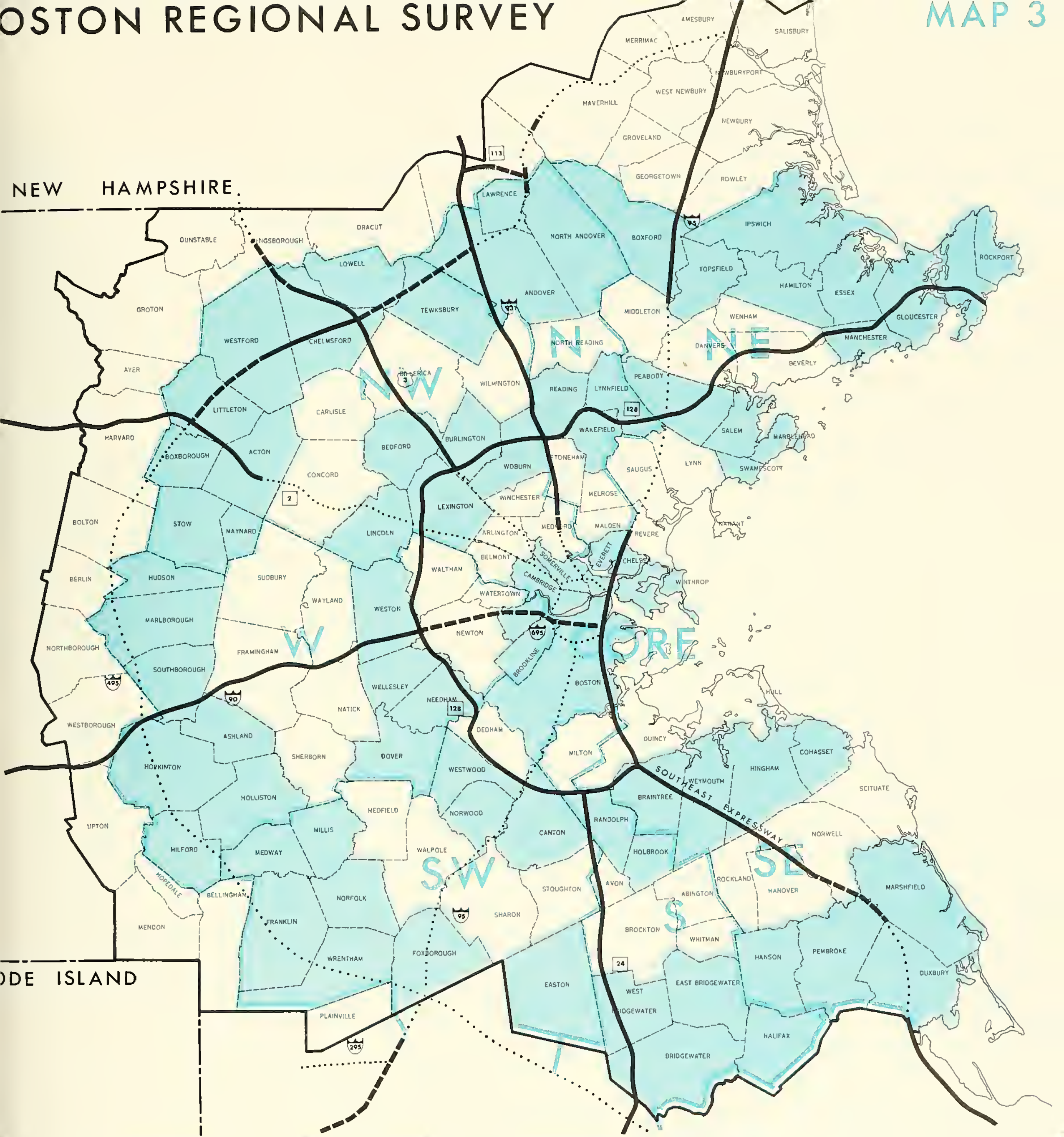
MAP 3



NER BELT STUDY
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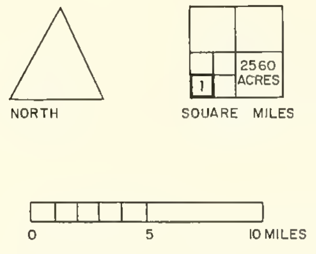

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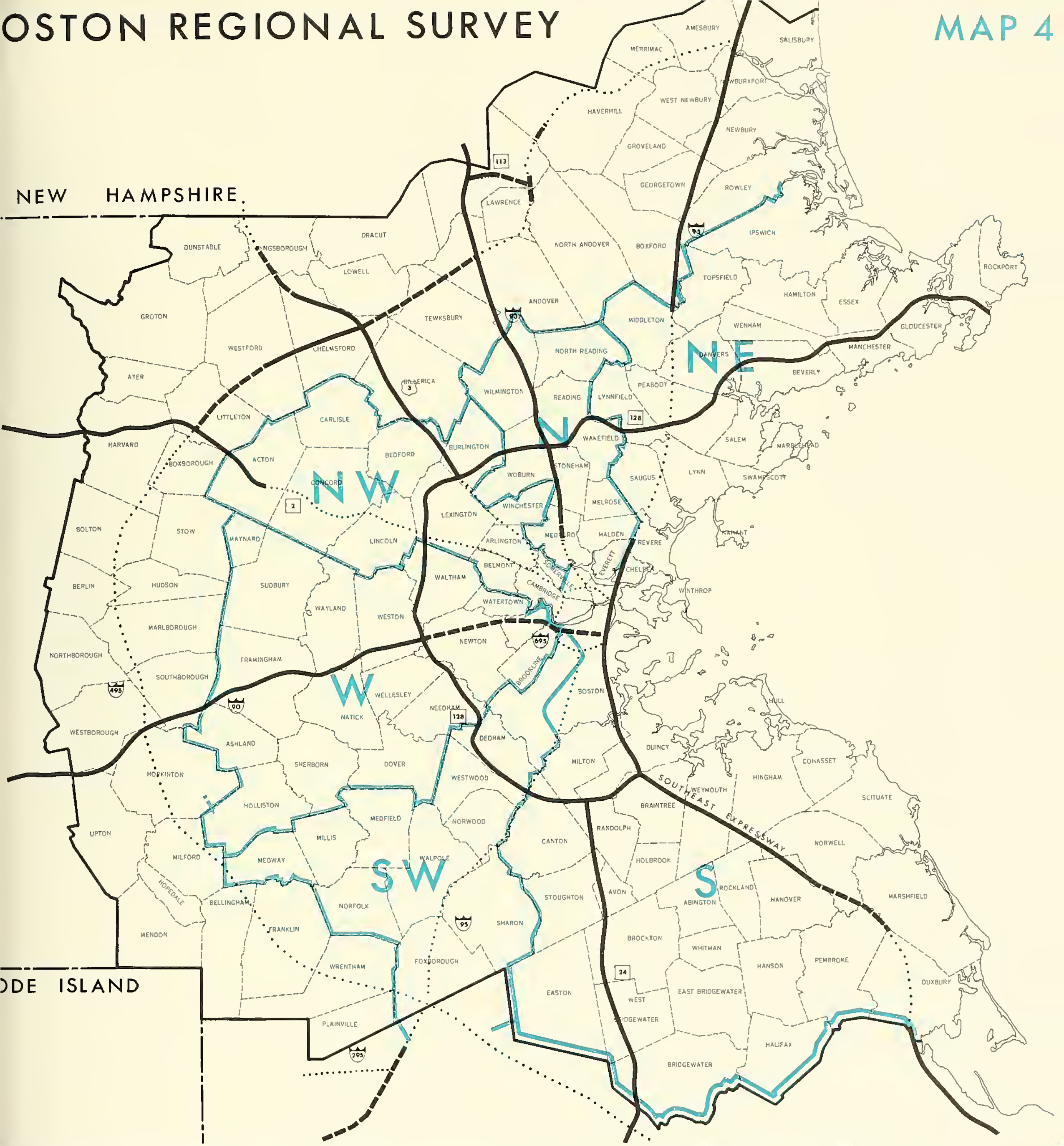
MAP 4



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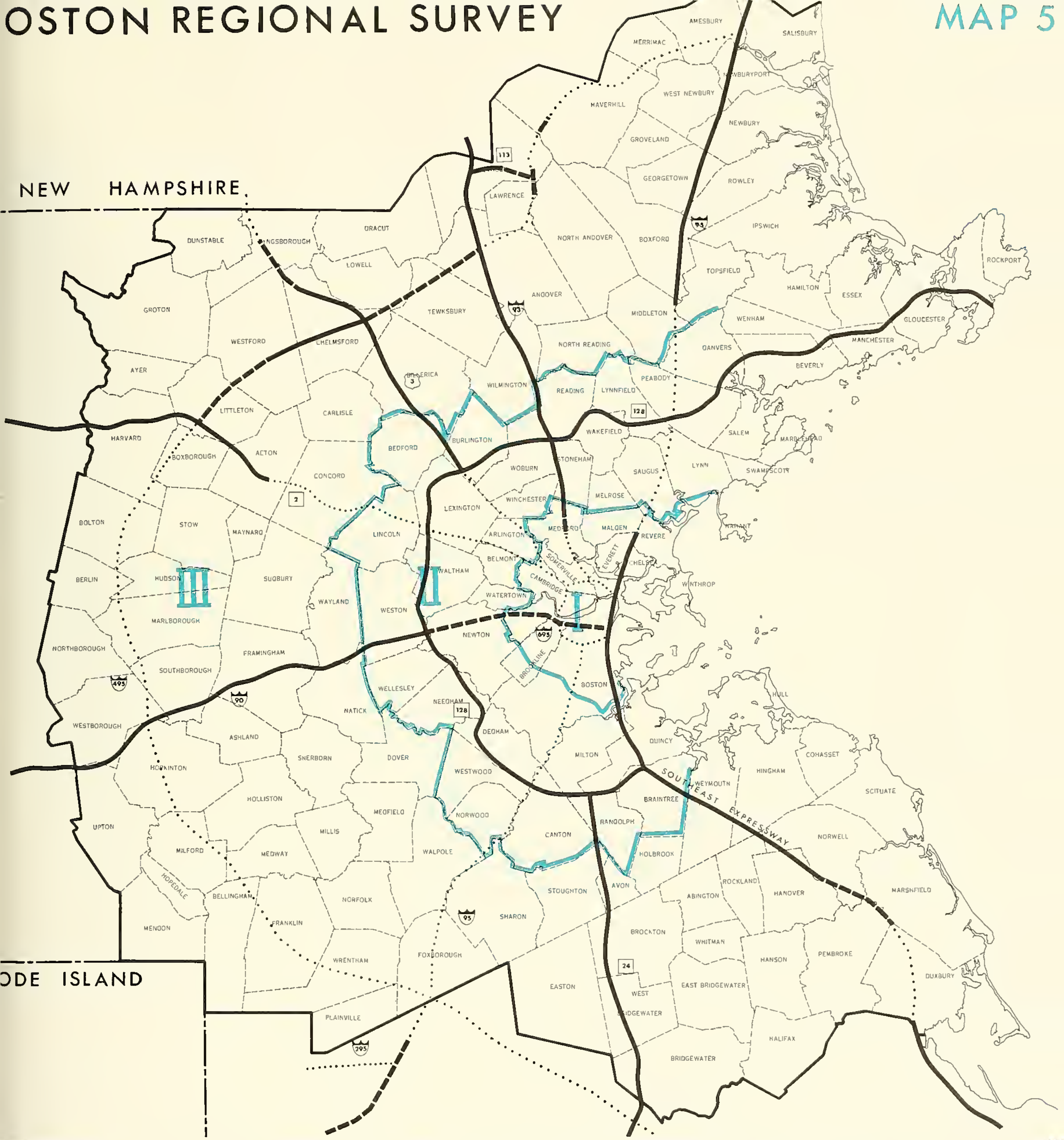

OUTE 128 STUDY
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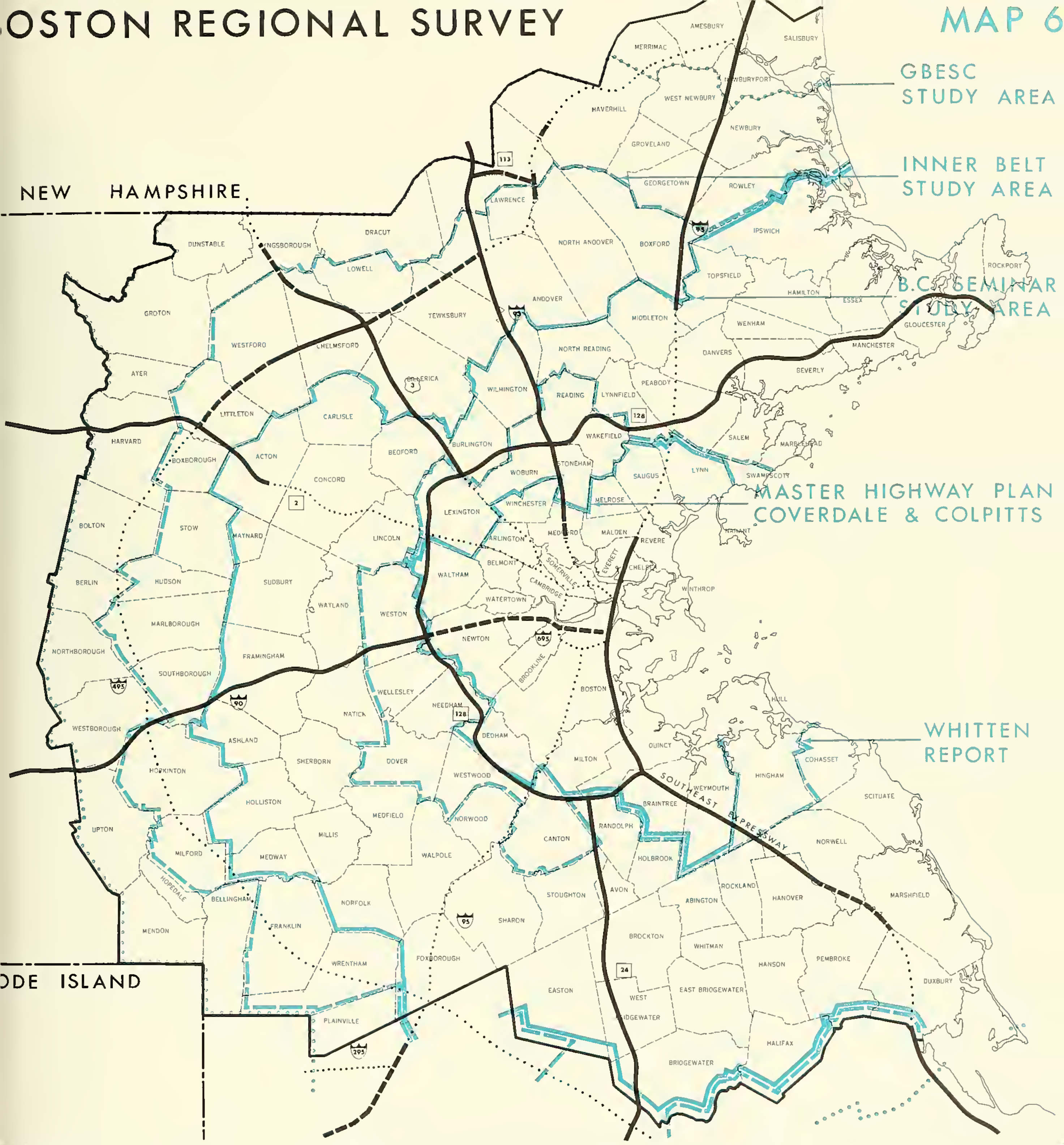
MAP 6



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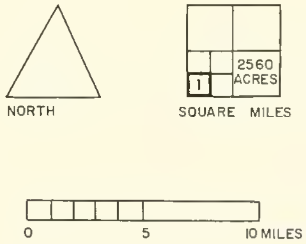

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